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OCCUPATIONAL CHARACTERISTICS OF WHITE MALE CANCER VICTIMS IN MASSACHUSETTS

1971-1973

SYNTHESIS OF THE RESULTS OF OCCUPATIONAL DISEASE SURVEILLANCE STUDIES: SETTING PRIORITIES FOR OCCUPATIONAL CANCER RESEARCH AND CONTROL

ROBERT DUBROW, M.D., PH.D.
AND
DAVID H. WEGMAN, M.D.

DR. FRECHETTE: May we start with your permission? I'm Al Frechette. What an excellent turnout we have today. The topic is certainly a timely one. Everyday, you read about some of the problems in connection with toxic substances. I'm very anxious myself to start this program. We have an outstanding group to discuss it and the first to present the problem, Robert Dubrow, is an Epidemiologist with the Surveillance Branch at the National Institute for Occupational Safety and Health (NIOSH), in Cincinnati.

Before coming to NIOSH last October, Dr. Dubrow was a Research Associate at the Harvard School of Public Health in the Occupational Health Program. While he was at Harvard, Dr. Dubrow worked on the study that is the subject of this program with Dr. Wegman, an Associate Professor of Occupational Health at Harvard. Dr. Dubrow received his medical and doctorate degrees at the University of Pennsylvania and did post-doctoral work at Harvard School of Public Health. Dr. Dubrow?

DR. DUBROW: Thank you Dr. Frechette. First I'd like to thank the Department of Public Health for inviting me here and particularly Dick Clapp and Petra Langer who did most of the work in setting this thing up.

What I'm going to talk about today is based on two papers that Dr. Wegman and I wrote while I was at the Harvard School of Public Health. The first paper is called "Occupational Characteristics of White Male Cancer Victims in Massachusetts 1971 - 1973". That was a study of death certificates in Massachusetts, about which I'm going to go into much greater detail in a few minutes. And the second one is called "Synthesis of the Results of Occupational Disease Surveillance Studies: Setting Priorities for Occupational Cancer Research and Control." That study was an attempt to synthesize the results of 12 studies that were similar in type to the Massachusetts study. I'll explain more about that also in a few minutes.

I'd just like to say that the opinions that I'm going to express, and if I say "We think this," or "We think that," I'm basically talking either about the opinions of myself or myself and Dr. Wegman, and it doesn't mean that it's a NIOSH position, necessarily. That doesn't mean that NIOSH would disagree with it but it's not the kind of thing that NIOSH has taken official positions on.

The first thing I'd like to do is to try to put the occupational cancer problem in some perspective. And this is a difficult thing to do. As most of you know, estimates of the proportion of cancers due to occupation have ranged anywhere from one to forty percent. I'm not going to add anything to that controversy today, because really, the data doesn't exist to settle that controversy. What I would like to try to do is to draw out what the implications of even a conservative estimate of occupational cancer would mean. In a major paper by Doll and Peto in 1981, entitled "The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today," they estimate that 15 percent of male lung cancer deaths are due to occupation, and they warn that that estimate might be a little high. I think it might be a little low, but nevertheless, they take an overall conservative approach in attributing cancers either to occupation or environmental pollutants. So, I think most people in the field would consider that to be a realistic estimate and not something that was way out in left field.

And in the next overhead we show what that would mean in terms of male cancer deaths. As you can see, if we say that 15 percent of all lung cancer is due to occupation, and 85 percent is due to smoking, then occupational lung cancer becomes the fifth leading male cancer. This is behind cancer of the pancreas which is a major cancer killer. And then, of course, if we add other occupational cancers which definitely are known to exist, such as occupational bladder cancer, leukemia, cancer of the nasal sinuses, etc., it would certainly push it up into fourth place in terms of male cancer deaths. Again, this would be a conservative way of looking at it.

Now, preventing cancer of the pancreas would be considered a major public health accomplishment; and the difference between cancer of the pancreas and occupational cancer is that at least in principle, occupational cancers are preventable.

This study of occupational cancer in Massachusetts, as well as the other studies which I'm going to talk about today fall under the category of occupational disease surveillance studies. Basically, these are studies which examine either mortality or incidence patterns of large numbers of diseases over a large number of occupations and industries. So, they're broad, sweeping type studies that try to look at a lot of different things.

The next overhead lists most of the major studies of this type that have been done. They fall into two major categories in terms of the data base that is used. In the first type, death certificate records are used. Those studies are listed up on the top-such as the study that was done in the United States as a whole in 1950, several different state studies, and some studies done in England and Wales. You can see that the Massachusetts study is on the smaller side in terms of the number of subjects looked at. Then the second type of data base is the Cancer Registry Data Base. A cancer registry essentially tries to register every case of cancer that occurs in a particular geographical area, usually. If those collect proper information, they could be used for this type of study. In addition, NIOSH has a program to support states in doing this type of surveillance study. New data has just come in from four states -- Rhode Island, Utah, Maine and upstate New York -- but that's new data, so I won't talk about that any further.

What I would like to talk about now is why we do surveillance studies, what their uses are and what their limitations are. The main reason for doing this type of study is that you can take advantage of a large number of records that are easily accessible that have information on both occupation and cause of death, and which can be analyzed relatively simply and cheaply. But there are also a lot of limitations to this type of study. One of the main implications of the limitations is that with this type of study alone, you can't prove a cause/effect connection between an occupation and a type of cancer. This is because they are relatively crude studies and they have a very limited amount of information. I'm going

TEN LEADING CANCERS
MALE DEATHS-1979

CANCER	DEATHS
LUNG (DUE TO SMOKING - 85%)	61,883
COLORECTAL	25,404
PROSTATE	22,240
PANCREAS	11,023
LUNG (DUE TO OCCUPATION - 15%)	10,920
LEUKEMIA	8,890
STOMACH	8,650
LYMPHOMAS	7,600
BLADDER	6,709
ORAL CAVITY AND PHARYNX	5,877

OCCUPATIONAL DISEASE SURVEILLANCE STUDIES

VITAL RECORDS STUDIES

STUDY	NUMBER OF SUBJECTS WITH MALIGNANT NEOPLASMS
United States 1950	43,100
California 1959-61	33,000
Washington State 1950-71	50,000
Rhode Island 1968-72	4,900
Massachusetts 1971-73	16,600
England and Wales 1959-63	204,200
England and Wales 1970-72	142,900

CANCER REGISTRY STUDIES

STUDY	NUMBER OF SUBJECTS WITH MALIGNANT NEOPLASMS
Roswell Park 1956-65	6,400
Third National Cancer Survey 1969-71	3,500
Los Angeles County 1972-77	21,700
England and Wales 1966-67	113,900
England and Wales 1968-70	184,900

to get into that a little further in a minute. But why they're important is that when they are interpreted in conjunction with other studies and other research, and also in conjunction with hypotheses about potential occupational carcinogens, they could provide important clues or hypotheses for conducting more definitive, in-depth investigations of particular cancers or particular occupations. In addition, they are important for trying to set priorities for occupational cancer research and control.

An additional major shortcoming of these studies as a group to date has been a relative lack of study of women and especially minority groups. The four new states all have data on women, so that will be an improvement. But minorities are still a problem, and it would be important to try to fill that gap with states in the South or states like Michigan where there is a large black industrial population.

A final shortcoming of the studies that exist to date is that they don't present a complete picture of the whole spectrum of occupations and industries. In other words, except for a few of the studies like the 1950 U.S. Study, which is somewhat out of date anyway, when you concentrate a study on a particular state, you will miss certain industries that are not in that state. So for example, auto manufacturing, which is a major industry, really wouldn't be covered by most of what's been done. You want a study in Michigan for that; or for the textile industries, you'd want to study the South, etc.

Now what I'd like to focus on, since we used death certificates in the Massachusetts study, is what the inherent limitations of using death certificates are. The next overhead shows the basic information from the death certificate that is used in doing this type of study. It's basically just four things: underlying cause of death, the person's usual occupation that they did in their lifetime, the industry or business, and the age at death.

The next overhead lists some of the limitations of the death certificate data. The first limitation is that there is no information on potential confounding variables, such as smoking, alcohol consumption or diet. So, for example, if you find that a particular occupation has an excess of lung cancer, there are at least two possiblilitties as to why that's the case. One is that there is an occupational exposure that's causing the excess lung cancer. The other is that people in that particular occupation smoke more than the general population. There is no way in this kind of study to distinguish between those two possibilities.

The second limitation is the limited accuracy of the cause of death statement on the death certificate. Generally, for any specific form of cancer, it's been found to be about 60 to 70 percent accurate. The way this has been determined is by comparing the cause of death statement with clinical data from the hospitals or with autopsy findings--by going back and making that comparison.

The third limitation is the inherent problem of assigning a single cause of death. For example, when you're interested in cancer, if someone had colon cancer, and also died of a heart attack, then they might very well be assigned heart attack as their underlying cause of death. You would miss the cancer - that is the kind of inherent misclassification that you

RELEVANT DEATH CERTIFICATE INFORMATION

- UNDERLYING CAUSE OF DEATH
- USUAL OCCUPATION
- INDUSTRY OR BUSINESS
- AGE AT DEATH

LIMITATIONS OF DEATH CERTIFICATE DATA

1) NO INFORMATION ON POTENTIAL CONFOUNDING VARIABLES (E.G. SMOKING, ALCOHOL CONSUMPTION, DIET)
2) LIMITED ACCURACY OF CAUSE OF DEATH STATEMENT
3) PROBLEM OF ASSIGNING A SINGLE UNDERLYING CAUSE OF DEATH
4) LIMITED ACCURACY OF OCCUPATION AND INDUSTRY STATEMENTS
5) PROBLEM OF USING USUAL OCCUPATION

CONSEQUENCES

o DILUTION OF EFFECTS

o POSSIBLE BIASES

o CAN GENERATE LEADS, BUT CAN NOT PROVE A CAUSAL ASSOCIATION run into in this kind of study.

The fourth limitation is the limited accuracy of the occupation and industry statements; again, these have been found to be about 60 to 70 percent accurate by comparing the statements on the death certificate either with interviews with next of kin, or with the occupational statement on the U.S. Census for the same people who died in the same year.

The fifth problem is the inherent problem of using the usual occupation, because that limits the scope of what you could look at and creates potential biases. For example, if someone worked for 10 years as a plumber and then for 20 years as a truck driver, the only information you would have is the usual occupation of truck driver. In a more refined study, you would definitely want to have a complete occupational history for the person.

So the consequences of these limitations are first, you could expect to get a dilution of effect, and that would just be if you had random misclassification either of occupation or cause of death. But in addition, there are possible biases if some causes of death or occupations tend to be selectively misclassified into others. And thirdly, again, this means that these kinds of studies could generate leads but can't prove a causal association.

On the next overhead is some of the basic background on the Massachusetts study. It was a study of adult white males, meaning ages 20 and above. The study was of 1971 - 1973 death certificates. There were about 35,000 subjects with about 16,600 malignant neoplasms. And what it consisted of was all malignant neoplasm deaths for that period plus a one in four sample of other deaths to serve as a comparison group. There were 62 malignancy categories and that included grouped categories. For example, the category of leukemia as well as the categories of myeloid leukemia and lymphatic leukemia, etc. There were 397 occupation categories, including grouped categories that were groups of occupations you might expect to have similar exposures. Motor vehicle drivers is an example of a grouped category - which would be a group of individual categories such as truck drivers, bus drivers, taxi drivers, etc.

The next overhead shows the basic method that was used to assess the relative mortality for different occupations. It's a measure called Mortality Odds Ratio, which is the ratio of the mortality odds between the cancer of interest and other auxiliary causes of death for the occupation of interest compared with the non-exposed comparison group. The auxiliary causes of death in this study were all deaths except for cancer deaths and cirrhosis of the liver,and the nonexposed comparison group was all other occupations. The Mortality Odds Ratio is expressed as a percentage, so this means that if a MOR is 100, there was no excess or deficit of the cancer. If it's greater than 100, there was an excess proportional in magnitude to how much greater it is than 100, and if it's less than 100, there was a deficit for the cancer for that particular occupational group.

Now, in this method, you are making a certain assumption which is that the mortality rate for the auxiliary causes of death -- the other causes of death, the noncancer causes of death (except for cirrhosis of the liver) --

MASSACHUSETTS STUDY

- ADULT WHITE MALES
- 1971-1973 DEATH CERTIFICATES
- 34,879 SUBJECTS
- 16,629 MALIGNANT NEOPLASMS
- 62 MALIGNANCY CATEGORIES
- 397 OCCUPATION CATEGORIES

COMPUTATION OF MORTALITY ODDS RATIO

	OCCUPATION OF INTEREST	NON-EXPOSED COMPARISON GROUP
CANCER OF INTEREST	A	B
AUXILIARY CAUSES OF DEATH	C	D

$$\mathrm{MOR} = \frac{A}{C} \Big/ \frac{B}{D} = \frac{AD}{BC}$$

is constant for all occupations. And that assumption is not true. But you have to make certain assumptions to do an analysis. It's actually a conservative assumption in a way because a lot of studies have shown that for many causes of deaths, the mortality rate is greater for lower socioeconomic groups than it is for higher socioeconomic groups. Also, most of the types of occupations where you would expect occupational cancers are in lower socioeconomic (blue collar) type occupations. So, the way the bias would work is that it would actually lower the Mortality Odds Ratio that you would see in the blue collar types of occupations for cancer. So, in that sense, it's a conservative type of bias for the most part. The mortality odds ratios were adjusted for age, and significance testing was done in the study using a standard method called the Mantel-Haenszel Method.

Now I'd like to get into the results of the Massachusetts study. Actually, first I'd like to talk about some of the factors to take into consideration in interpreting the results. Those are shown in the next overhead.

The first and very important factor is confirmation of the results by other studies-consistency; consistency in this type of study is extremely important. This is because many of the associations that are seen in any one study like this are going to be chance associations. This is true any time a large number of statistical comparisons are made such as we're doing in this study. A certain number will be statistically significant by chance alone.

In addition, some associations will be artifacts due to the particular methodology used or the particular data base used. However, if the same association between the particular occupation and particular type of cancer is consistently seen from study to study, then the chances that it's a real association become greatly enhanced.

The second factor is the possibility of confounding factors or biases explaining the results -- that has to be thought about for any particular result. The only way of going at it is to just think about what possible biases or confounding factors could be involved in this particular result.

And a third factor is the likelihood of an occupational exposure to known or suspected carcinogenic agents. That's an important factor, but if you can't think of a likely occupational exposure, but you get a consistent result for a particular association, that doesn't mean that you should throw that result out, because it might be something new that hasn't been thought of before. So it's something that needs to be looked into. Just for example, in applying these principles, if you found that in one study of this type that cashiers had a very high level of lung cancer, but that wasn't true in any of the other studies, and also there is no obvious exposure for cashiers that you would expect to cause lung cancer, you wouldn't take that result very seriously. It might either be an artifact of that particular study or a chance association. On the other hand, if you find that plumbers in nine out of ten studies of this type have excess lung cancer, you would take that very seriously because there are a number of potential exposures for plumbers.

FACTORS IN INTERPRETING RESULTS

- CONFIRMATION OF RESULTS
- POSSIBILITY OF CONFOUNDING FACTORS OR BIASES EXPLAINING RESULTS
- LIKELIHOOD OF OCCUPATIONAL EXPOSURE TO KNOWN OR SUSPECTED CARCINOGENIC AGENTS

Now I'll present some of the highlights of the Massachusetts study. And what I'll do after that is talk about the results of the second study which synthesized information from 12 studies of this type. This synthesis really is a very powerful way of amplifying the results of these studies, and it is relevant to the occupational cancer problem in Massachusetts.

There is one more thing I want to say before I show the actual results, and that's another limitation. Not much really showed up for two major Massachusetts industries: the health care industry and the high technology industry. But I just wanted to warn that that doesn't mean that there is not a problem in those industries. In terms of the health care industry, it's 85 percent women workers, and among the men workers, there is a fairly high proportion of black and Hispanic workers, so this study for the most part didn't cover the health care industry. In terms of high technology industry, it's a relatively new industry, mostly appearing after World War II. For cancer, you expect at least a 20 to 30 year lag period before that starts showing up. And also, it's a relatively young population of workers, so there wouldn't be that many deaths. So that's why this study doesn't really deal with those two industries very much.

In our opinion, the most significant result of the study is the large number of occupations which were found to have lung cancer excesses for which there are reasonable hypotheses as to possible occupational exposures and which are supported by other studies of this type as well as by other types of research.

The next overhead lists the occupational categories which had lung cancer excesses in this study. Now, what I mean by excesses is either that the results were statistically significant, or what we call borderline statistically significant, and we had a certain definition for that which I won't go into. But that's what we mean by a cancer excess. Now, these tables basically list the occupations that were found to have excesses that were also supported by other studies from the literature and where there were also potential carcinogenic exposures. This includes some of the well-established occupational lung cancers such as asbestos and insulation workers and ship-yard workers. But it also includes a lot of others that are not yet well established.

The next overhead shows some of the results for cancers other than lung cancer where there were significant or borderline significant associations and where there was also support for these excesses from other studies in the literature. I'm going to go into a few of these in more detail in a few minutes.

On the next overhead we go into a few of these in a little more detail. For shipyards and cancer of the lung, you could see that a number of the shipyards subcategories as well as shipyards as a whole, which is on the bottom, had excess lung cancer. In these tables, in the MOR column, two pluses mean that it was significant at P less than .01; one plus at P less than .05. You could see that shipyard workers in this study had a 50 percent excess of lung cancer. It was very significant.

TABLE 5

OCCUPATIONAL CATEGORIES WITH LUNG CANCER EXCESSES, SUPPORT FROM OTHER STUDIES,[#] AND POSSIBLE CARCINOGENIC EXPOSURES*

Occupation	Possible Carcinogenic Exposures$	Other Studies+
121 bakers	combustion products	
123 boilermakers	asbestos, welding fumes	(59,60)
125 brickmasons, stonemasons, tile setters	asbestos, cement dust	**
138 heavy equipment, construction equipment operators	gasoline and diesel engine exhaust	(61,62)
154 machinists NEC	cutting fluids, abrasives, metal fumes and dusts	(27,52,63)**
158 mechanics and repairmen, automobile;	asbestos, oil mists, gasoline and diesel engine exhaust	**
159 mechanics and repairmen NEC++		**
185 shoemakers and repairers	dyes and glues, leather dust	(63)
190 tinsmiths, coppersmiths, sheet metal workers	welding fumes, asbestos	**
192 tool and die makers, tool makers, etc.	cutting fluids, abrasives, metal fumes and dusts	
211 asbestos and insulation workers	asbestos	(64)
217 bus drivers	gasoline and diesel engine exhaust	
219 clothing pressers	asbestos	(63)
220 conductors, bus and street railway	gasoline and diesel engine exhaust	

TABLE 5 continued

OCCUPATIONAL CATEGORIES WITH LUNG CANCER EXCESSES, SUPPORT FROM OTHER STUDIES,# AND POSSIBLE CARCINOGENIC EXPOSURES*

Occupation	Possible Carcinogenic Exposures$	Other Studies+
244 steelworkers, wire workers	coke oven emissions, oil mists	(65)
255 truck and tractor drivers	gasoline and diesel engine exhaust	(63,66)**
273 cooks, chefs (except private household)	combustion products	(27,59,63,67)**
303 fishermen and oystermen	diesel engine exhaust	(27,68)**
306 longshoremen and stevedores	asbestos, pesticides	(63)
344 carpenters (expanded)	asbestos, wood dust	(27,50)
346 painters (expanded)	solvent and paint fumes, asbestos	(59,63,67)**
347 plumbers (expanded)	asbestos, welding fumes	(27,51,59,63)**
358 foundry workers (expanded)	silica, polycyclic aromatic hydrocarbons	(69)
360 heated metal workers	metal fumes and dusts	**
372 vehicle drivers	gasoline and diesel engine exhausts	(25)**
382 bar workers	smoke filled rooms	(63)
384 custodial, maintenance, cleaning workers	cleaning chemical fumes, asbestos	(63)
395 shipyards	asbestos	(70)

TABLE 4

SOME OCCUPATION-CANCER ASSOCIATIONS (OTHER THAN LUNG CANCER) SUPPORTED BY STUDIES IN THE LITERATURE OTHER THAN THOSE IN TABLE 1*

Occupation	Cancer	References
111 chemists	pancreas	(39)
131 compositors and typesetters	prostate	(40)
148 jewelers, watchmakers, silversmiths	pancreas	(41)#
202 chemcial workers	bladder	(42-44)
243 rubber workers	myeloid leukemia	(45)
249 shoe factory workers	leukemia and aleukemia	(46)
251 leather workers, tanners	bladder	(43,47)
285 hairdressers and cosmetologists	bladder	(47-49)
331 medical workers	bladder	(44,49)
344 carpenters (expanded)	stomach, leukemia, multiple myeloma	(50)
347 plumbers (expanded)	esophagus, lymphatic and hematopoietic tissue	(51)
350 machinists and related occupations	stomach, large intestine, and other digestive system	(27,52-54)
	bladder	(44,48,49)
351 printing trades	buccal cavity and pharynx	(55)
359 welders (expanded)	prostate	(56)
389 farmers	multiple myeloma	(57)
393 large employer B - abrasives products	large intestine and rectum	(58)#

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* This table was not based upon a thorough literature search, but upon the author's current knowledge of the literature.

# The death certificate data used in these studies and this report overlap.

SHIPYARD
TRACHEA, BRONCHUS, AND LUNG

OCCUPATION	OBSERVED	EXPECTED	MOR
BOATBUILDERS; CARPENTERS, SHIPYARD	6	3	201
ELECTRICIANS, SHIPYARD	8	9	92
MACHINISTS, SHIPYARD	18	7	270++
PAINTERS, SHIPYARD	9	3	261+
PLUMBERS, SHIPYARD	5	4	112
SHIPYARD WORKERS NEC	27	19	141
WELDERS, SHIPYARD	3	3	110
SHIPYARDS	108	72	152++

The next overhead shows the category vehicle drivers and lung cancer. Again, most of the vehicle driver sub-categories had excess lung cancer. In particular, I'd like to point out the truck driver category with an MOR of 173. And it was a big category so it was highly significant -- 176 cases. The group as a whole had an MOR of 145 and that was also very highly significant. I'm going to talk about this a little more later, but a potential occupational carcinogen is gasoline exhaust or diesel engine exhaust.

The next overhead shows results for machinists and related occupations, in a younger age group. We did some analyses by age groups. This is the 20 to 54 year old age group for cancer of the lung. The group as a whole had an MOR of 171 for machinists and related occupations. In addition, for this younger age group, something that could be of potential significance is that cancer of the colon and rectum was also found to be very significantly elevated in this group. Just in the 20 to 54 year old age group. Also cancer of the stomach was elevated in machinists and related occupations in the entire age range. There is support from other studies for those excesses. Possible carcinogens are cutting oils and abrasives which are used in different grinding operations.

The next overhead shows results for printing trades and cancer of the oral cavity and pharynx. As you can see on the bottom again, for the group as a whole, the MOR was 252 and again this was highly significant. This result is supported by some other studies in the literature and there are also some obvious exposures such as solvents and oil and ink mists.

Now what I would like to do is to tie things together by showing some of what we found by synthesizing the results of 12 occupational disease surveillance studies. These are the ones that were listed in the overhead towards the beginning of the talk. The method that was used in combining the results was fairly elaborate and I won't go through the whole method, but I would just like to point out some of the basic principles which are shown in the next overhead.

There were three final criteria used for choosing the strongest and most consistent occupational cancer asociations from among these 12 studies. The first was that, in terms of significance, P was less than .05 for a quantity that we called the aggregate observed to expected ratio. I'm not going to go into how we calculated that except to say that what it is essentially is a weighted average for any given occupation/cancer combination of the observed to expected ratios in each of the individual studies. The second criterion was that the association be significant in at least three of the different studies. And the third was that at least 80 percent of the studies have an observed to expected ratio of 120 or greater for the particular occupation/cancer of interest. If an association met any of these three criteria, it was included in the final selection as one of the strongest and most consistent associations. By using this method, we picked out 178 occupation/cancer associations.

The results which stood out the most were the results for lung cancer in this analysis. There were 34 occupational categories found to be assoc-

VEHICLE DRIVERS
TRACHEA, BRONCHUS, AND LUNG

OCCUPATION	OBSERVED	EXPECTED	MOR
HEAVY EQUIPMENT, CONSTRUCTION EQUIPMENT OPERATORS	18	6	295++
BUS DRIVERS	24	18	132
CONDUCTORS, BUS AND STREET RAILWAY	10	4	259+
DELIVERYMEN AND ROUTEMEN	13	12	105
TAXICAB DRIVERS AND CHAUFFERS	38	32	118
TRUCK AND TRACTOR DRIVERS	176	102	173++
FUEL OIL TRUCK DRIVERS AND LABORERS	11	14	81
DRIVERS NEC	23	20	115
FORK LIFT DRIVERS	6	4	142
MOVERS, MOVING TRUCK DRIVERS	4	7	59
VEHICLE DRIVERS	305	211	145++

MACHINISTS AND RELATED OCCUPATIONS
TRACHEA, BRONCHUS, AND LUNG, AGES 20-54

OCCUPATION	OBSERVED	EXPECTED	MOR
JOBSETTERS AND DIESETTERS, METAL	1	1	---
PRECISION MACHINE OPERATIVES	3	2	172
MACHINISTS NEC	27	15	184++
MACHINISTS, SHIPYARD	2	0	---
MILLWRIGHTS	2	2	107
PATTERN AND MODEL MAKERS, METAL	0	1	0
TOOL AND DIE MAKERS	8	3	269+
FILERS, GRINDERS AND POLISHERS, METAL; METAL CUTTERS	1	3	29
MACHINISTS AND RELATED OCCUPATIONS	44	26	171++

PRINTING TRADES
ORAL CAVITY AND PHARYNX

OCCUPATION	OBSERVED	EXPECTED	MOR
COMPOSITORS AND TYPESETTERS	3	1	438
ELECTROTYPERS AND STEROTYPERS	1	0	---
PHOTOENGRAVERS, LITHOGRAPHERS, AND COMPOSERS	--	--	---
PRESSMEN AND PLATE PRINTERS, PRINTING	9	4	257++
PRINTING AND PUBLISHING WORKERS NEC	2	1	186
PRINTING TRADES	15	6	252++

FINAL CRITERIA FOR CHOOSING STRONGEST AND MOST CONSISTENT OCCUPATION-CANCER ASSOCIATIONS

1) $p < .05$ FOR THE AGGREGATE OBSERVED TO EXPECTED RATIO (USING BAILAR AND EDERER'S TABLE OF SIGNIFICANCE FACTORS FOR THE RATIO OF AN OBSERVED VALUE OF A POISSON VARIABLE TO ITS EXPECTATION).

2) ASSOCIATION SIGNIFICANT IN AT LEAST THREE (3) STUDIES.

3) AT LEAST 80% OF THE STUDIES HAVE AN OBSERVED TO EXPECTED RATIO OF 120 OR GREATER (MINIMUM OF FOUR (4) STUDIES).

iated with lung cancer, and every one of them was a blue collar occupational category for which there are reasonable exposure hypotheses.

The next overhead shows the nine occupations which were found to be most strongly associated with lung cancer using this analysis. I'll just run down them: asbestos and insulation workers, which was not unexpected, came in as number one. Metal molders, plasterers and lathers, boilermakers, painters, brickmasons - stonemasons - tile setters, fishermen and oystermen, tinsmiths - coppersmiths - sheet metal workers and truck and tractor drivers. The table lists some of the parameters of interest in doing this analysis.

The next overhead shows the other occupations which were found to be associated with lung cancer in this analysis. I just listed these, I didn't present the numbers on them.

In examining the lung cancer results more closely, there were two main priorities for occupational cancer research and control which we think clearly stood out. We felt that investigation and control of asbestos exposure was the number one priority in occupational cancer research and control. The reason for this is that, of the 34 categories that had excess lung cancer, 18 have known or expected exposure to asbestos.

The next slide lists those occupational categories. In addition, of the nine categories which were most strongly associated with lung cancer, six have known asbestos exposure. Those were the asbestos and insulation workers, plasterers and lathers, boilermakers, painters, brickmasons - stonemasons - tile setters, and tinsmiths - coppersmiths - sheet metal workers. These results really support the need for a comprehensive national program to prevent asbestos exposure. While it's possible that the cancer excesses in these occupations aren't due to asbestos exposure, it's certainly a likely possiblility that they are. We think that industrial hygiene investigation to document more closely what the asbestos exposures are in most of these occupational categories is needed. Specifically, the exposure among asbestos workers and in shipyards has been pretty firmly established, so in terms of research, that isn't really a priority, although exposure is not necessarily well-controlled in those groups. But it is well established. So, we think that, in particular, the construction industry and the automobile repair industry deserve special attention at this point. As you can see, most of the construction trades, as well as construction laborers, were found to have excess lung cancer and other asbestos-related cancers such as stomach cancer, cancer of the larynx, cancer of the oral cavity and pharynx, cancer of the esophagus. There are more than 4.5 million construction workers in the United States, and asbestos is employed in a wide variety of products used in the construction industry. It's generally recognized that asbestos exposure occurs in the construction industry, but very little work has been done in actually documenting under what circumstances and to what extent exposure occurs. This is something that really needs to be done and exposure needs to be controlled.

In terms of the automobile repair industry, there are more than one million workers in this industry. And as you can see, there were three

CANCER OF THE TRACHEA, BRONCHUS, AND LUNG, $P < .01$

	NUMBER OF STUDIES	NUMBER SIGNIFICANT	NUMBER WITH OBS/EXP 120	AGGREGATE OBSERVED	AGGREGATE OBS/EXP
ASBESTOS AND INSULATION WORKERS	3	2	3	36	285
MOLDERS, METAL	8	4	7	126	148
PLASTERERS AND LATHERS	4	2	3	64	147
BOILERMAKERS	6	2	5	81	142
PAINTERS	9	8	8	172	140
BRICKMASONS, STONEMASONS, TILE SETTERS	8	5	7	134	137
FISHERMEN AND OYSTERMEN	7	4	4	111	132
TINSMITHS, COPPERSMITHS, SHEET METAL WORKERS	8	4	7	143	128
TRUCK AND TRACTOR DRIVERS	9	8	5	180	125

OTHER OCCUPATIONS WITH EXCESS LUNG CANCER

P<.05

- STEELWORKERS, WIRE WORKERS
- SHIPYARD WORKERS
- FURNACEMEN, SMELTERMEN, POURERS
- BLACKSMITHS, FORGEMEN, HAMMERMEN
- HEATED METAL WORKERS
- HEAVY EQUIPMENT, CONSTRUCTION EQUIPMENT OPERATORS
- BUS DRIVERS
- MECHANICS & REPAIRMEN, AUTOMOBILE AND OTHER VEHICLES
- CRANEMEN, DERRICKMEN, HOISTMEN
- TAXICAB DRIVERS AND CHAUFFERS
- MECHANICS AND REPAIRMEN NEC
- CUSTODIAL, MAINTENANCE, CLEANING WORKERS
- DELIVERYMEN AND ROUTEMEN
- PLUMBERS AND PIPEFITTERS

3 SIGNIFICANT

- MOTOR VEHICLE DRIVERS
- STATIONARY ENGINEERS AND FIREMEN
- COOKS, CHEFS
- SAILORS
- CONSTRUCTION INDUSTRY WORKERS
- WELDERS AND FLAMECUTTERS
- CARPENTERS AND CABINETMAKERS
- MACHINISTS
- MINERS
- CONSTRUCTION LABORERS NEC

80%>120

- ROOFERS AND SLATERS

TABLE 9

Occupation With Known or Suspected Asbestos Exposure[a] Found to Have Excess Lung Cancer and Other Asbestos-Related Cancers

Occupation	Cancer Excesses
Construction industry workers	lung
• Asbestos and insulation workers	lung
• Plasterers and lathers	lung, stomach
• Painters	lung
• Brickmasons, stonemasons, tile setters	lung, stomach
• Tinsmiths, coppersmiths, sheet metal workers	lung
• Heavy equipment, construction equipment operators	lung
• Plumbers and pipefitters	lung, esophagus
• Carpenters and cabinetmakers	lung, stomach
• Construction laborers NEC	lung, larynx
• Roofers and slaters	lung, buccal cavity, and pharynx
Mechanics and repairmen, automobile and other vehicles	lung, esophagus, buccal cavity, and pharynx
• Mechanics and repairmen NEC	lung, esophagus, stomach
Boilermakers	lung
Shipyard workers	lung
Stationary engineers and firemen	lung
Welders and flamecutters	lung

TABLE 10

Motor Vehicle Driver Categories With Excess Lung Cancer

Occupation	Number of Workers[a]
Motor vehicle drivers	3,511,000[b]
Truck and tractor drivers	1,965,000
Bus drivers	358,000
Heavy equipment, construction equipment operators	444,000
Taxicab drivers and chauffeurs	164,000
Deliverymen and routemen	580,000

[a] 1979 Bureau of Labor Statistics estimate ( ).

[b] Sum of the number of workers in the five more detailed categories listed below.

asbestos-related cancers found in automobile mechanics: lung, esophagus, and buccal cavity or oral cavity and pharynx. Significant asbestos exposure has been documented among this group of workers especially in the repair of brake and clutch linings. If this situation is typical, and there is no reason to think it isn't, a program to institute industry-wide control measures is needed.

I'd just like to note, though, that the carcinogenic exposures in these 18 groups where there is known or expected asbestos exposure need not be limited to asbestos. For example, automobile mechanics are exposed to welding fumes, to chromium, to nickel, to engine exhaust and to various oils as well as to asbestos. So, again, asbestos is not necessarily the complete answer, but it's very likely in most of these occupations that it does contribute signficantly to the lung cancer excesses that were found.

Okay, so asbestos is the first priority. The second priority we felt was motor vehicle drivers. The next overhead lists the motor vehicle driver categories that were found to have excess lung cancer, which were the grouped category of motor vehicle drivers as well as every motor vehicle driver sub-category that was examined. As you can see, that included truck drivers, bus drivers, taxi cab, heavy equipment and consturction equipment operators, aand deliverymen and routemen. There are more than 3.5 million motor vehicle drivers in the United States.

In addition to lung cancer, it was found that the grouped category of motor vehicle drivers had excess cancer of the larynx, and truck drivers had excess cancer of the larynx and esophagus. Both of these types of cancer you would expect from inhaling carcinogenic agents. The obvious potential exposures are gasoline and diesel engine exhaust. To our knowledge, there have been no studies of exposure of vehicle drivers to gasoline and diesel engine exhaust, and we think that this type of study is needed.

One thing I'd like to mention here is this question of smoking vs. occupation: That smoking itself could in a lot of situations be looked upon as an occupational cancer problem. In this case, one hypothesis which has been made about the excess of lung cancer in motor vehicle drivers is that because of smoking cigarettes in an enclosed space, in an enclosed cab, that that would intensify the exposure. This could be interpreted as a smoking problem, but it's also an occupational problem: the problem of ventilation.

The third priority which we saw was machinists and related occupations, and this is shown in the next overhead. This lists the cancer excesses which were found in machinists and related occupations in the analysis of combining the 12 occupational surveillance studies. So, machinists had excess lung cancer. Tool and die makers had excess colon and bladder cancer and filers, grinders and polishers had excess stomach cancer. There are more than 1.5 million workers in this category, and as I think I mentioned before, there is support from other studies in the literature for these excesses. The possible exposures include cutting fluids and abrasives.

CANCER EXCESSES IN MACHINISTS AND RELATED OCCUPATIONS

OCCUPATION	CANCER
MACHINISTS	LUNG
TOOL AND DIE MAKERS	COLON, BLADDER
FILERS, GRINDERS, AND POLISHERS	STOMACH

Now what I'd like to talk about just for a minute is the question of smoking vs. occupation, because with lung cancer as well as other smoking related cancers such as pharynx, oral cavity, larynx, esophagus and bladder, some people tend to downplay the importance of occupational association; their argument is that the excesses can largely or fully be attributed to cigarette smoking because blue collar workers smoke more than white collar workers do. That is a true statement: Blue collar workers do smoke more than white collar workers do, at least in the studies that have been done on the subject. However, our point of view on this question is that in a situation where you have an occupation/cancer association in which there are two possible explanations, either the occupational group smokes more than the rest of the population or there is a potential occupational exposure, an exposure that reasonably could be thought to cause lung cancer, that it would obviously be irresponsible to just say that the cancer must be due to smoking. You know, it has to be investigated in each case individually, in depth, to figure out why are these people getting excess lung cancer or cancer of the larynx or whatever. In addition, there is some evidence on this issue that indicates that in most or in many of these situations, the excesses can't be explained solely by cigarette smoking.

In summary, then, our analysis of the 12 occupational disease surveillance studies points to three priorities for occupational cancer research and control. The first one is asbestos, and this is primarily a control problem, because we know that asbestos causes a number of types of cancer. It's just a question of doing more work to find out where the exposures occur and then controlling them. The construction industry and automobile repair industry are priorities in that regard.

The next two priorities - motor vehicle drivers and machinists and related occupations - are more research problems at this point. Because we don't yet know whether these represent true occupational cancer problems or whether these excesses that are seen are an artifact of some sort or other, but certainly at this point there is enough information that warrants some real in-depth studies of these two categories.

I'd like to close with some suggestions about what the implications are for an occupational cancer program in Massachusetts. Those are presented in the final overhead. Well, first I'd like to say that I think the motor vehicle driver and machinist problems aren't problems that are particular to Masschusetts, so those are considered to be more in the realm of national research needs. That's why I didn't list them in this overhead.

In terms of cancer surveillance, number one is the Cancer Registry. As most of you probably know, there is a Cancer Registry that is just getting underway in Massachusetts, and I think that this is an extremely important undertaking. One of the reasons for this is that the Cancer Registry is collecting information on occupation. At this point, most cancer registries in the United States don't collect information on occupation. The use of cancer registries for surveillance is a qualitatively better method than the use of death certificates. First of all, there is a potential for collecting much higher quality data than you could get from death

PRIORITIES IN OCCUPATIONAL CANCER RESEARCH AND CONTROL

- ASBESTOS

  CONSTRUCTION INDUSTRY
  AUTOMOBILE REPAIR INDUSTRY

- MOTOR VEHICLE DRIVERS

- MACHINISTS AND RELATED OCCUPATIONS

OCCUPATIONAL CANCER PROGRAM FOR MASSACHUSETTS

SURVEILLANCE:
- CANCER REGISTRY
- DEATH CERTIFICATE STUDY OF WOMEN AND MINORITIES

SELECTED EPIDEMIOLOGIC STUDIES:
- HEALTH CARE INDUSTRY
- HIGH TECHNOLOGY INDUSTRY

CONTROL OF KNOWN HAZARDS
- MAJOR PRIORITY: ASBESTOS

OCCUPATIONAL DISEASE CLINICS

RIGHT TO KNOW

WORKERS' COMPENSATION FOR OCCUPATIONAL CANCER

PHYSICIAN EDUCATION

the important aspects of an occupational cancer program on a state level; in terms of what the goals are. This much, at least, would be a good thing to do. Thank you.

DR. FRECHETTE: Starting the panel discussion is Dr. David Gute, who is a Public Health Epidemiologist with the Rhode Island Department of Health, Office of Health Systems Planning; he is also visiting Research Associate at the Harvard School of Public Health. Dr. Gute received his Master's and Doctorate degrees from Yale University. The subject of his Doctoral dissertation was Occupational and Industrial Mortality in Rhode Island.

DR. DAVID GUTE: Thank you very much. I will exercise the same level of precaution that was asked for by Rob and state that any opinion that I express will be my own and not necessarily that of my employer. I also might begin by paraphrasing a statement that John F. Kennedy once made in that I seem to have the best of both worlds: a Yale degree and a Harvard source of employment.

By way of introduction, I'm an epidemiologist with the Rhode Island Department of Health and, contrary to popular opinion, twentieth century civilization has actually spread that far out of the realm of Metropolitan Boston. I assume one of the reasons my being asked to serve as discussant has to do with work concerning the effects of employment on health that I've been associated with in Rhode Island. It will be useful for me to quickly review this work, I think, to provide a context for some of my comments.

I'm attached to a health planning unit in the Rhode Island Department of Health that has a few basic operational characteristics. One of those is that it tries to base a lot of policy action on solid epidemiologic information. The second is that before proceeding with a long list of interventions or attempted interventions, one should best be able to describe the dimensions of any public health problem. And third, that the allocation of resources (and, increasingly, we are dealing with more and more finite resources in dealing with public health problems) should be commensurate with risk. So these are three basic concerpts that we brought to the area of occupational health in Rhode Island.

In association with the NIOSH Surveillance Branch, we've been lucky enough to have a Cooperative Agreement along with three others states: Utah, Upstate New York and Maine. Over the past two years we have been attempting to develop surveillance techniques that are transportable to other states, that are cheap and efficient, that use available data and that, hopefully, provide meaningful information.

In the process of dealing with this program, we, in Rhode Island, have coded over 100,000 death certificates for the period of time 1968 to 1978 looking at industry and occupation, an analysis which is strikingly similar both in method and result to the Dubrow and Wegman paper presented here. The results of these analyses have served to focus public attention on the relationship between occupational exposures and health and, also, have directly contributed to the development of a series of recommended intercertificates. This could go all the way to the point of (ideally) doing patient interviews where you could directly as well as other information such as smoking information.

In addition, there is an advantage to using incidence data-which the Cancer Registry collects. This goes back to the problem of ideally wanting to identify for this type of study every person who gets the particular cancer. As I mentioned, with the death certificates, the underlying cause of death could be stated to be something other than cancer, but the person could have had the cancer in addition to whatever else they died from, so the cancer would be missed.

The second thing (I also should say in making these suggestions that I realize that these are pie-in-the-sky in terms of current resources - but they are something to shoot for) would be a death certificate study of women and minorities. In terms of minorities, the way this would have to be done, since there is a relatively small minority population, would be to do it over a greater number of years - to look over a ten or twenty year period instead of a three-year period like my study.

The second suggestion is selected epidemiologic studies. Two areas to think about focusing on would be the health care industry and the high-technology industry, since those are two major Massachusetts industries.

The third suggestion is the control of known hazards, and again, the major priority seems to be asbestos. Then, there are other types of measures which don't really touch on what I've talked about, but I thought I should just mention them: Those include the development and support of occupational disease clinics; Right-to-Know legislation, meaning the rights of workers to know what hazardous materials they're working with; worker's compensation for occupational cancer (at present, less than one percent of occupational cancers receive worker's compensation); and physician education.

In terms of occupational disease clinics and physician education and the problem of occupational cancer, I think that there are several contributions that these measures could make. One is to promote early detection of cancers. A second is to aid in the monitoring of the occupational cancer problem since, at the present time, I would have to say that most occupational cancers are never recognized as occupational cancers because they don't tend to be looked for. Also, it's very important in terms of issues around worker's compensation and employer liability to identify what is an occupational cancer. Right-to-Know laws, have been passed in a number of localities around the country. In Cincinnati, where I live, one is going to start to be implemented next month. It was passed several months ago and it took a little time to gear up. I understand that Right-to-Know legislation is being introduced in Massachusetts, and I think that there are people in the audience who know a lot about that and who, I hope, will comment more about that in the discussion period.

In conclusion, again, I realize that right now it's difficult to implement a lot of these things, but I think it would be good to talk about what are ventions as contained in the State Health Plan, the Rhode Island State Health Plan, and other planning documents issued by the Department of Health. I shall return later in my remarks to a fuller description of these interventions.

Now that I have provided a context for my comments, I'd like to address the Dubrow-Wegman papers. As a first comment, it should be pointed out that these papers are in a series of similar analyses that have been conducted both in this country and abroad. It is sobering, indeed, to recall that the British have pursued similar analyses since 1851 and as far back as 1864 the annual report of Vital Statistics in Rhode Island reported cause of death by sex, age and occupation of the decedent. So let us understand that this study reported here today is part of a long history of similar inquiries.

Having said that, there are new and exciting contributions made by the Dubrow-Wegman analysis. The first of these is the introduction of a relatively new method of analysis, the age-standardized Mortality Odds Ratio. I will not dwell on this subject in the interest of time but the important point to remember is that epidemiology is concerned with the distribution of disease and, because of this, comparisons must be made. The MOR, like the more familiar SMR and PMR, is one more analytic tool to affect such comparisons.

Potentially, the greatest methodological contribution of these papers is the exhaustive comparisons provided for the results reported here and the eleven studies conducted in the United States and abroad. Such comparison and synthesis is valuable on many levels and represents exhaustive and tedious hours of work due to the differences in occupational and disease coding schemes, periods of analysis and methods of analysis.

But, obviously, the most important contribution that this evidence represents today to this audience is the fact that this analysis has been completed for a Massachusetts population. Such an analysis by its very nature can serve to focus public debate with this presentation as the recent media coverage of the findings can so well document.

As this is the real world, there are also additions to the Dubrow-Wegman analysis that I would like to have seen. Rob has already mentioned a few. As we have done in Rhode Island, I think the addition of women workers as well as minority workers represents a very real and valuable contribution that should be pursued vigorously in this State. I also think the analysis should be pursued, perhaps, by industrial categories as well as occupational categories as reported on here today.

A third item that also might expand the utility of this analysis is not just to confine yourself to the underlying cause of death but expand analysis to include all causes of death mentioned on the certificate, multiple cause analysis, because particularly in occupational conditions you would like to have as sensitive an indicator of response or disease as possible and multiple cause is one way to go at it.

But the true value of any activity such as this report must include an assessment of what occurs or what happens as a result of its being carried out. Given the findings presented here, what are reasonable courses of action which may be charted? This question brings the mechanisms of science and public policy into a state of tension. Science as part of its long tradition is a discipline which is inherently conservative. Public policy, by its very nature, is dynamic, action-oriented. This presents a basic dichotomy which society is in the midst of grappling with. How do we, as a society, translate scientific data into meaningful public policy? In the protection of human health, this question cannot be more acute or difficult.

The mortality data presented here present this classic, interpretive quandary. It is important to keep in mind the caveats which are inseparable from this form of analysis and have already been touched on by Rob -- the reliability and accuracy of the death certificate data, both applying to cause, occupation and industry, are paramount in any assessment of this analysis. There were no direct data that could be introduced in terms of the personal risk factors suffered or expected of the workers covered in this analysis, as well as the fact that no direct information on the types of occupational exposures could possibly be gleaned from death certificate data about the decedents.

However, the types of data, as was the case in Rhode Island, can be valuable in the justification of a variety of intervention activities. Some of the intervention activities that we proposed in Rhode Island have to do with, first, the formulation of analytical studies sufficient to characterize more fully the hypotheses that are developed in analysis of this type. These types of studies, as has already been pointed out, are most useful in the generation of hypotheses and the business of public health agencies and other actors in the State is now to follow up on some of these leads and actually do some analytic epidemiology to test more fully and characterize these hypotheses.

We should use the results of studies of this nature to allocate occupational health resources commensurate with risk. This type of approach is embodied in Rob's call for active control of asbestos in the workplace. It makes a lot of sense to allocate resources along with a firm look at risk and this is an idea which has come, I think, relatively late to the field of occupational health in an era where we're fighting for every dollar in the public health sector; it can only bear greater fruit if we use this as a dictum in the future.

We must also improve the supply of accurate information for both employers and employees in terms of occupational health hazards. One particularly useful way, I think, of doing this (and this has seen light in Rhode Island) is the introduction of at least two "Right-to-Know" pieces of legislation. I realize that there is some "Right-to-Know" legislation which is presently being considered in Massachusetts and we, at the R.I. Department of Health, have fully evaluated this and are going to try to throw our weight behind such legislation becoming a fact in Rhode Island. We hope to achieve something that offers a sufficient level of protection to workers as well as acceptability to industry, if that is possible.

And, four, is to establish and continue to support statewide tumor registries. One of the interesting things, as I look out at the audience, is that I think there are representatives from all four of the States now in New England that have tumor registries -- Connecticut is represented, Rhode Island, and now the beginning registries in Massachusetts and Maine.

Rob has nicely encapsulated some of the advantages of registry data. Intuitively, working at a public health agency, I would like to be able to deal with a data source that can actually have some preventive impact. Obviously, when you're analyzing death certificates, prevention is the last thing that you can actually hope to achieve, and, also, with registry data, I don't know if Rob mentioned this, but there's many more events that are available to study. It's always better to study morbidity than it is mortality and there's all kinds of advantages that accrue; I would heartily support any efforts to expand registries as well as expand their utility.

In summary, my comments have focused on the long tradition of studies similar to the one reported here today and how it fits into similar activities in other neighboring New England states. Two, I have briefly touched on the tension between scientific analysis and the conduct of public policy. This tension need not totally frustrate action but it always must be taken into account. Thirdly, and lastly, I have reviewed some possible intervention activities appropriate for following up the findings presented here today. As a last postscript, I'd just like to thank the organizers of this meeting for the opportunity to share some of my thoughts with you today. Thank you.

DR. FRECHETTE: Thank you, Dr. Gute. Now, from Massachusetts is Dr. Rose Goldman, the Occupational Health Physician for the Massachusetts Department of Labor and Industries, Division of Occupational Hygiene. She also serves as Chief of the Occupational Medicine Section of the Harvard Medical School's Division of Primary Care, as well as Chief of the Occupational Health Clinic at Cambridge City Hospital. Dr. Goldman received her medical degree from the Yale University School of Medicine, is Board-Certified in Internal Medicine, and she also holds Master's degrees in public health and occupational health from the Harvard School of Public Health. Dr. Goldman.

DR. ROSE GOLDMAN: As long as everybody else is giving their precautions as to how you're supposed to interpret their comments, I'm not speaking for Harvard Medical School. I do believe I'm speaking for the Division of Occupational Hygiene, however, and if I'm not, the Director is here and he can interrupt and correct me.

I'm going to take a really more practical approach than the other two speakers and, basically, speak to what can we do to define and control new hazards from the perspective of what we do in the Division of Occupational Hygiene. I think I'd like to take a minute for our neighbors who aren't familiar with the Massachusetts system just to let you know what the Division of Occupational Hygiene is. Our Director, Dr. Leonard Pagnotto, is a very experienced industrial hygienist who sits on national committees for setting industrial hygiene standards. Our Division also has a number of industrial hygienists and industrial engineers, never enough, of course, who actually go into the field and do measurements and do laboratory work within our Division. We respond to the requests of employees, employers or citizens who think that there is a health problem at the workplace and this service is provided, in some ways free, but through our tax dollars; it is probably one of the better uses of our tax money.

In addition to that, we have an Asbestos Commission that goes out and assesses workplaces for the presence of asbestos and advises on proper control measures; and, lastly, we have a group that at the request of the employer will go out in conjunction with the special OSHA program and help employers come into compliance with set OSHA standards.

So with that little introduction, let me just give some examples of how this might work and how this really fits in to the kind of information that we're getting from these Standardized Mortality Ratio (SMR) studies and information from the Health Statistics group. First of all, let's take what can we do about the hazards that we know exist. We've heard from Dr. Dubrow that asbestos is a known hazard and we already have good evidence it causes lung cancer. What are we doing about it? Well, in our Division, for example, we get calls frequently from construction workers saying, "We're ripping out a wall and there's this fluffy stuff coming down. Is this asbestos and are we doing the right thing?" Hopefully, we get called either before the process or during and not after, and then a group will go out and take some of the fibers, look at them under a polarizing microscope, determine that this is asbestos and tell the group that these are the kind of precautions you should be taking when you're doing this kind of construction job.

The group also goes out to schools or to other workplaces where the people may not even know if that asbestos pipe wrapping should be ripped out or covered up. So this is one service that we are providing to try to control a hazard that we already know needs controlling, and to address Dr. Dubrow's first priority.

Secondly, what about other hazards that are going on? And as another example, we worked with the Department of Public Health on an incinerator project where we thought hexavalent chromium, which is another carcinogen, was a by-product of the incineration process. While DPH was measuring the soil, we went out to examine the workers as well as to measure the ash they were handling to see if it contained any hexavalent chromium. It turned out that it contained very little, and we could then guide the people that owned the incinerators and the community in terms of what kinds of precautions needed to be placed on that incinerator.

As one last example, I go into factories frequently, again at the request of employers or employees. Just walking through the factory we can find that certain solvents are being used, many of which we know are hazardous, already have good information that they are carcinogens, and we strongly recommend that they use a safer solvent. Basically, what we're trying to do is to educate the people that we deal with whenever we go out to a workplace, either by getting Material Safety Data Sheets or other information together for them. I think this is a key thing because, basically, the controls that we can try to see happen are going to come at a local level when people themselves know what they're working with.

Unfortunately, we're severely limited in our Division; obviously, it's a spotty kind of intervention. We go out when we're called and we do the best we can to educate the people that call us and help to improve that particular workplace. We'd like to see a more pervasive outreach and that's one of the reasons that the Division of Occupational Hygiene is certainly behind and involved in the "Right-to-Know" legislation.

In addition, what can we do about those hazards that we don't even know are hazards, because, remember, the data that we're getting from these cancer registries and from these studies are reflecting the working conditions from twenty years ago that we're acting on now. And one of the hopes for cleaning up the workplace, based on an old time hazard or a suspected carcinogen, is when you make that change in the workplace to put in improved ventilation to clean up for example, benzene, what you're hoping might happen is by making that kind of an improvement you may also be eliminating unknown hazards that may also be causing trouble. The other side of that is that when you try to do a substitution and put in something that you think is safer, twenty years down the pike, you may then find that that's a carcinogen -- so that has its problems.

Lastly, I want to talk about what the role of a Division such as ours can be in following up on the leads that come out of these studies. We, hopefully, can help by doing a survey or assisting the Department of Public Health in doing surveys when you have a lead. For example, you've pointed out that there may be some problems in the leather industry or among machinists. Possibly, the Division of Occupational Hygiene could work with the DPH or those that are putting out the statistics to go to the machine shops and do measurements of the air to see what is currently being used there. We can say something about the substances in terms of what we already know is out there and what can be done to control the hazard. I'd like to point out that in the history of this Division, we have been able to contribute to controlling new hazards and defining them as a hazard. Dr. Harriet Hardy, who held this position number of years ago, for example, took suspicions that beryllium was related to lung disease, did surveys through the Division of Occupational Hygiene and was instrumental with other people in the Division to not only proving, or establishing, causality between beryllium and a chronic lung disease, and, also, trying to institute controls; and that would be my hope now as to how our Division could assist in following up on the statistical leads we're now getting from these studies.

So, to sum up, I'd like to say that a Division of Occupational Hygiene or a comparable division working in conjunction with the Department of Public Health can be an important force in controlling the hazards at the workplace, or, at least in supplying information to those people who could then act to control hazards at the workplace, whether that be by furnishing information to employers so they know what the risks are (I've been amazed at how many employers don't know and when you've informed them actually are quite cooperative in trying to clean up the place), informing the workers what it is that they're working with, what are the levels that they're working with and what are the protective measures that they're using, which they think are offering protection. And secondly, our Division can follow up on leads that we're now hearing about in terms of what might be hazards or potential hazards and confirm some of the leads that these studies are turning up.

DR. FRECHETTE: Thank you, Dr. Goldman. As I indicated to you earlier, Dr. David Wegman was not able to be here today and so Mr. Dick Clapp is going to substitute. Dick is Director of the Department's Cancer Registry. He received his Master's Degree at the Harvard School of Public Health and has done advanced work both in Occupational Health and Occupational Epidemiology.

MR. RICHARD CLAPP: What I'll basically try to do is add a visual footnote to what Rob and the other discussants have presented so far. I'd like to start by saying that the data that Rob presented, and which I will show some examples of, didn't appear by themselves. It took a lot of work by people in the Department of Public Health and I'd like to give credit where credit is due; some of those people are here in the audience, and these data are a result of their work, along with those who submitted the death certificate information and are now submitting reports to the Cancer Registry.

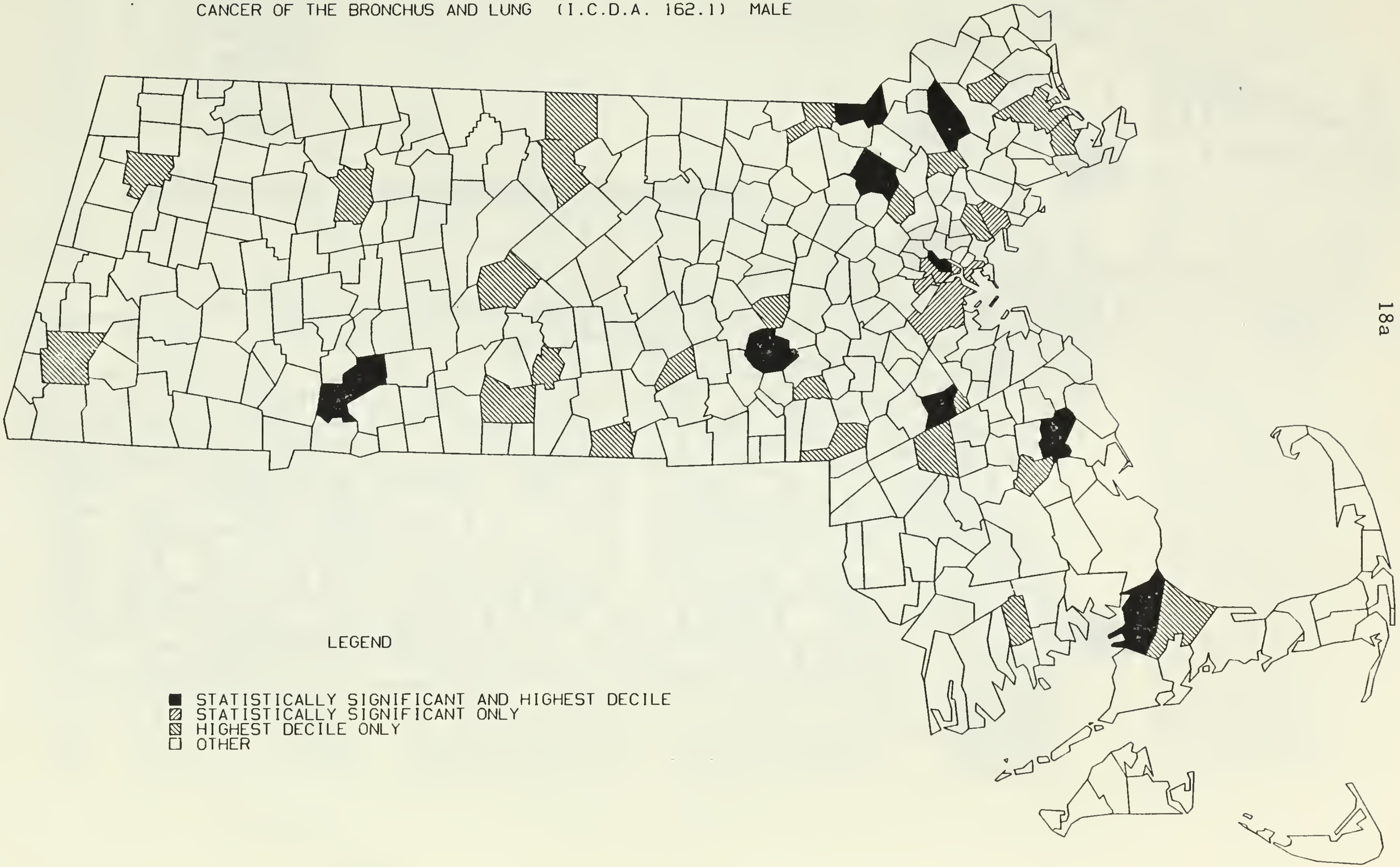
The visual footnotes that I wanted to add have to do with where cancer occurs in excess in Massachusetts. When we were planning this program, we started getting some phone calls asking, "Where are these people who have died from cancer and where are the industries located where the people worked?" In the case of the general statistics that I want to show you, I will attempt to visually display in what towns or in what geographic regions there are excesses. I will start with lung cancer.

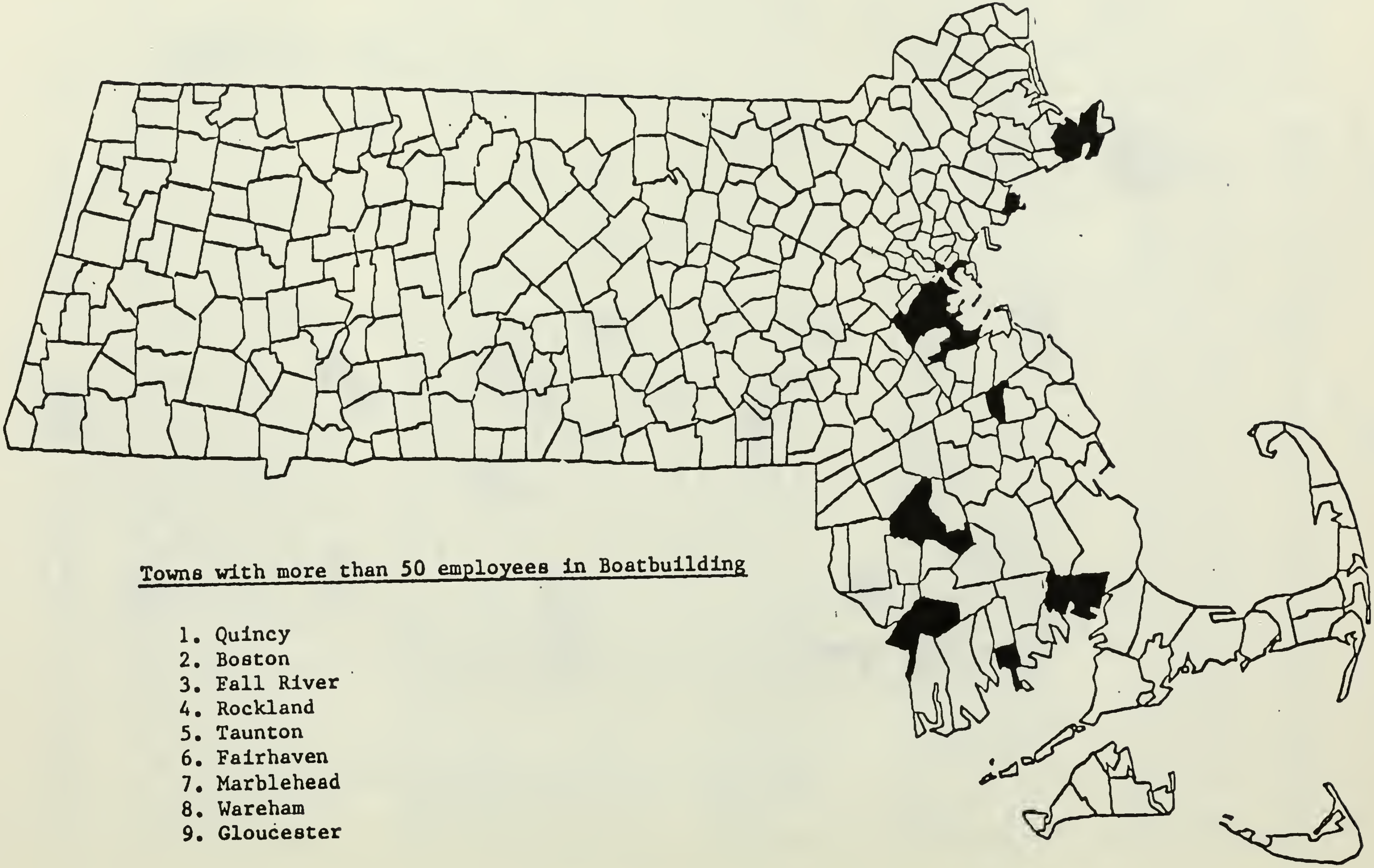
This first map is a summary of information that has been out for about two years in a publication called "Standardized Mortality Ratios for Massachusetts," and this is a little preview of a second part of that study which is due out later this year. This shows the towns where male lung cancer deaths were found in excess during the period 1974 - 78. Some of these towns I think you can recognize: This is Bourne (although there may be a problem in this particular town because a population estimate was incorrect because we didn't have census data), this is Pembroke, Stoughton, North Andover, Methuen, Billerica, Somerville, Hopkinton, Chicopee and West Springfield. Those are some of the towns where male lung cancer was found in excess above what was expected if the State average mortality rates applied in those towns.

I also want to show you a little about where industries are located in Massachusetts. This is where there are towns with more than fifty employees in the boatbuilding or shipbuilding industry. The biggest, of course, are Quincy and Boston, and then there are some smaller towns like Fairhaven. This small town here is Rockland, where the Boston Whaler plant is located; those are fiberglass boats and may not be a place where workers are exposed to asbestos. There is actually not too much overlap between where lung cancer is found in excess in those years and where the shipbuilding industry is located, but there are some correlations I'd like to show you with respect to two other industries.

The way these industry maps are compiled is by combining data provided by the Division of Employment Security in a publication called "Industrial

COMMONWEALTH OF MASSACHUSETTS MORTALITY RATES 1974-1978
CANCER OF THE BRONCHUS AND LUNG (I.C.D.A. 162.1) MALE


LEGEND
■ STATISTICALLY SIGNIFICANT AND HIGHEST DECILE
▨ STATISTICALLY SIGNIFICANT ONLY
▧ HIGHEST DECILE ONLY
☐ OTHER



Towns with more than 50 employees in Boatbuilding

1. Quincy
2. Boston
3. Fall River
4. Rockland
5. Taunton
6. Fairhaven
7. Marblehead
8. Wareham
9. Gloucester

Profile of Massachusetts, 1970 through 1977." In this next map, I combined the towns where the textile mill products, leather and leather products, and rubber and miscellaneous plastics products industries are located. Those three industries are known to be associated with excess bladder cancer. This composite shows where there are concentrations of employees in Massachusetts; and the next map shows where male bladder cancer occurred in excess from 1974 - 78, and you can see that there is a fair amount of overlap.

DR. FRECHETTE: It's unfair to make them overlap.

MR. CLAPP: Dr. Frechette, if you didn't hear, said it's unfair to make them overlap. I'm not sure exactly what he means, but I want to say in defense that these are not "cause and effect" maps. These are just descriptive statistics and I would not call them an epidemiologic study or proof of anything; they simply graphically show an association that is known to exist and which has been established by numerous studies.

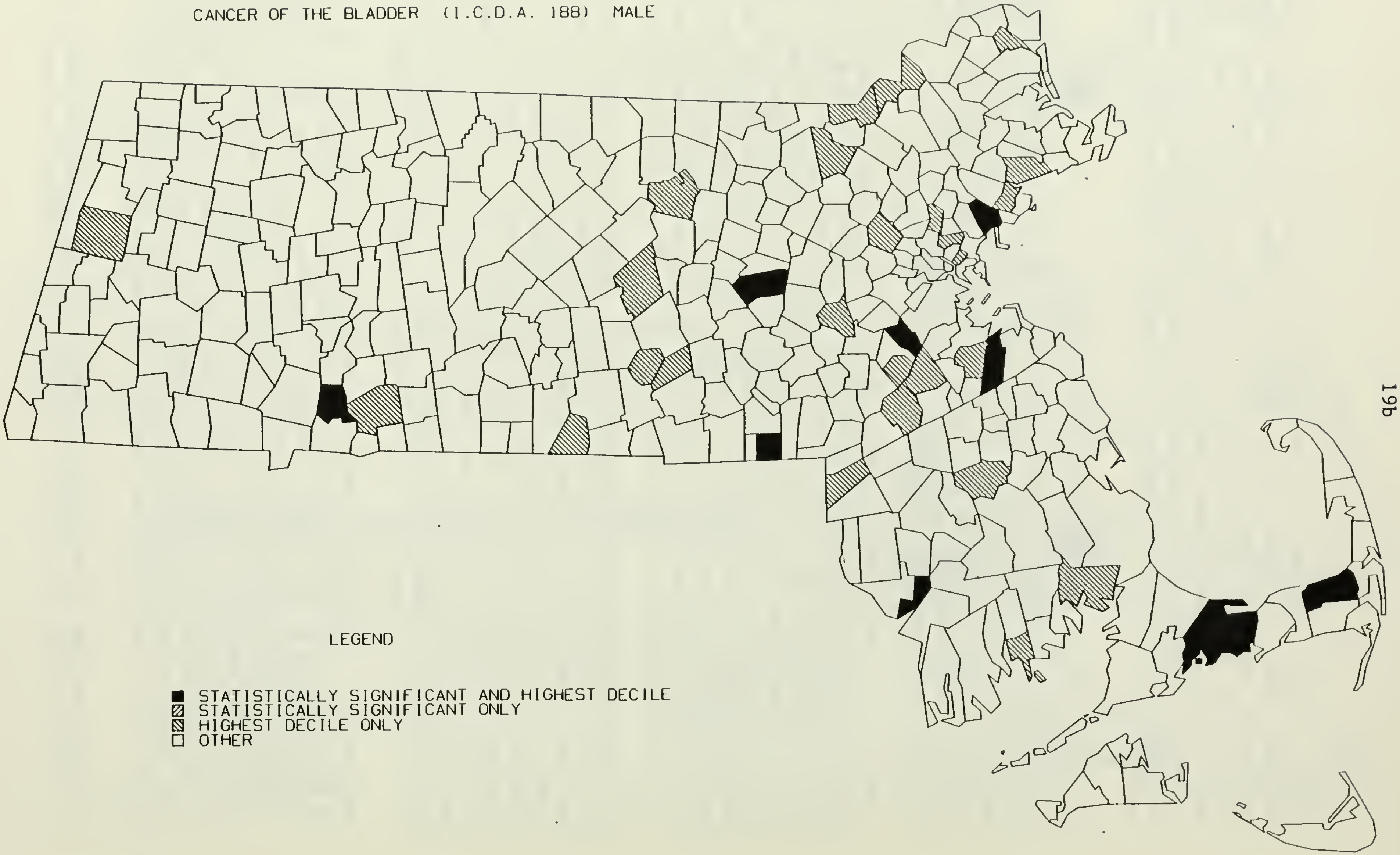
I want to show one other association which directly comes from Dr. Dubrow's talk, and that has to do with machinists and related occupations and where they're located in the State. This next map shows the towns where there are concentrations of employees in machinery (excluding electrical), electrical and electronic machines, instruments, and miscellaneous manufacturing industries. Those are the industries in which machinists work in greatest number in Massachusetts. Again, these statistics all come from the Division of Employment Security, from the Job Market Research unit. They are basically compiled in order to show potential employers where they could locate and get a lot of people who could work in their industry.

So, machinists and related occupations were concentrated in these towns in the State from 1970 - 77. And this next map shows where cancer of the stomach was found to be in excess in males in 1974 - 78; there are six or seven towns where it was statistically significantly elevated and in the highest decile for SMR's. Some of those towns where stomach cancer was elevated correspond directly to where machinists and related occupations were concentrated. So those are what I would call graphic or cartographic footnotes to what Rob and the other panelists have already discussed. They were prepared to answer the question, "where are the people located who work in certain occupations or died of certain cancers in the State?"

That was the first point I wanted to make, and the second point is simply to give you an example of the kind of occupational information that we're now collecting in the cancer incidence registry. Cancer case reports, which are filled out in each Massachusetts hospital where patients are diagnosed, are abstracted from the hospital records and sent in to us. It's usually done by a Tumor Registrar and then sent in to the State so that it can be part of statistical reports or serve as the basis for analytic studies which will be conducted from our data. Once again, I'd like to give credit where credit is due; without Tumor Registrars and Medical Records staff sending in these reports, we wouldn't be able to do any of this.

This next overhead is an example of what we're collecting and how it comes in; this is a real case that was diagnosed last February - the name and

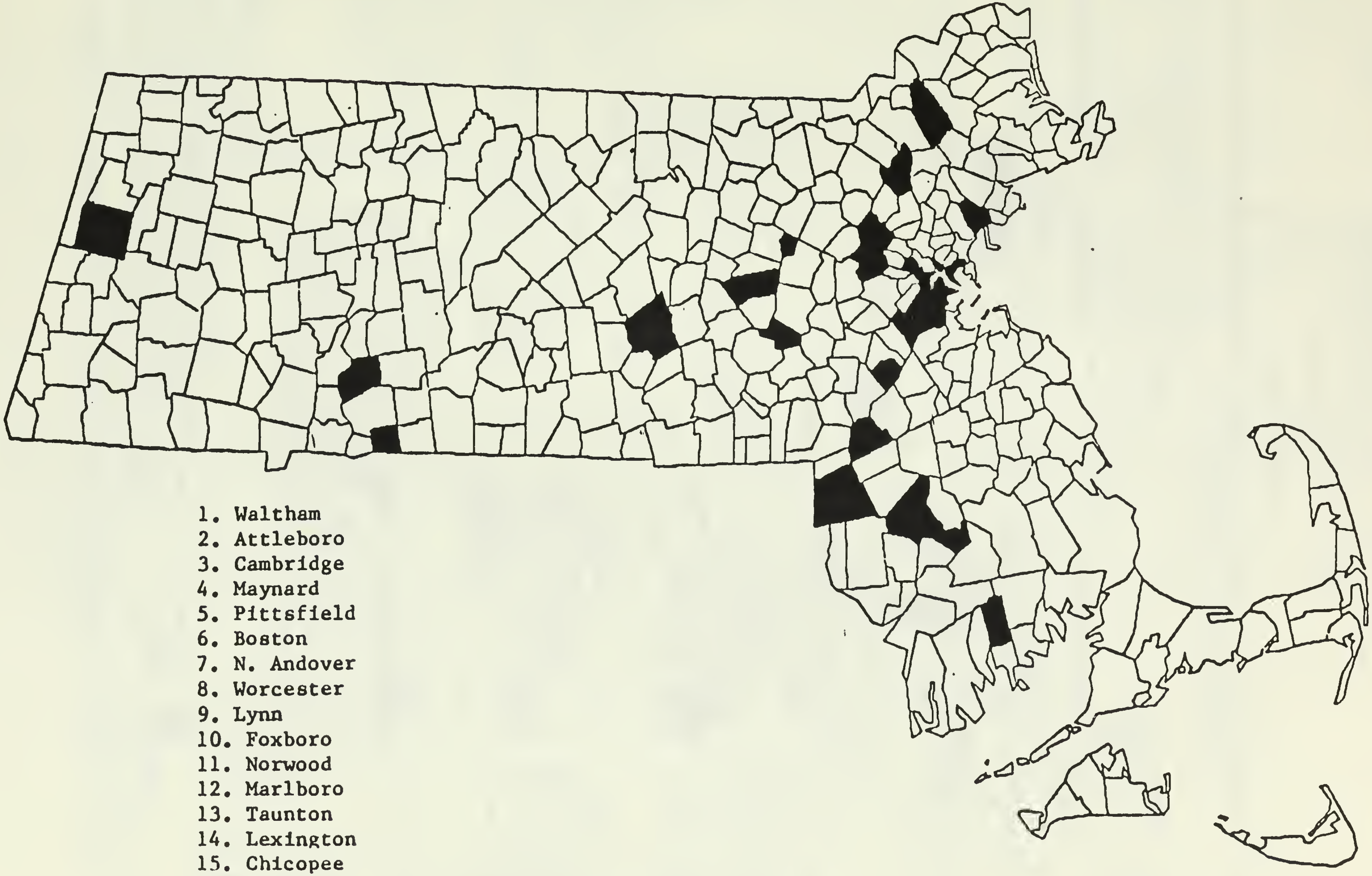
COMMONWEALTH OF MASSACHUSETTS MORTALITY RATES 1974-1978
CANCER OF THE BLADDER (I.C.D.A. 188) MALE



LEGEND

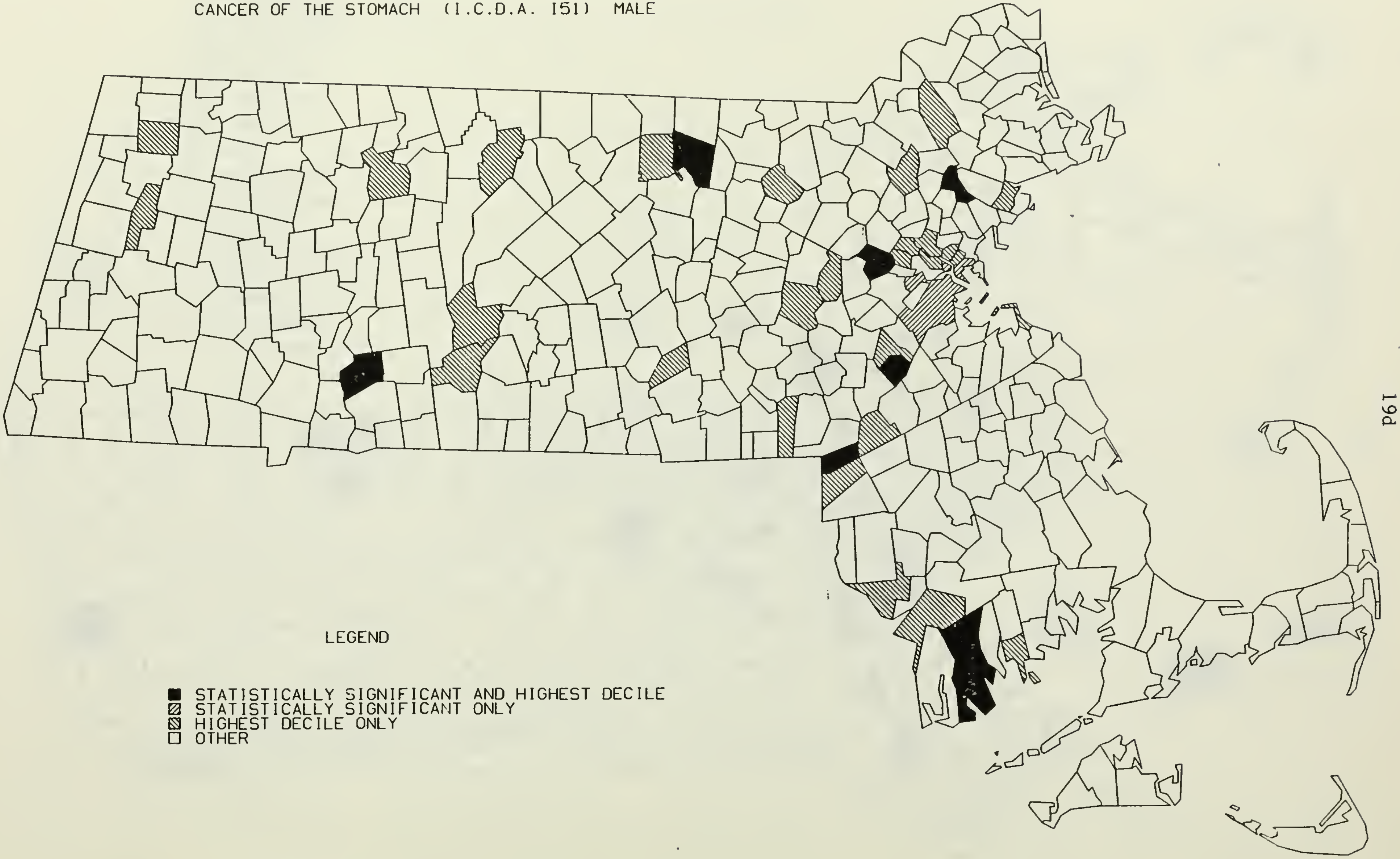
- ■ STATISTICALLY SIGNIFICANT AND HIGHEST DECILE
- ▨ STATISTICALLY SIGNIFICANT ONLY
- ▧ HIGHEST DECILE ONLY
- ☐ OTHER

Towns with concentrations of employees in Machinery (excluding electrical), Electrical and Electronic Machinery, Instruments, and Miscellaneous Manufacturing Industries



1. Waltham
2. Attleboro
3. Cambridge
4. Maynard
5. Pittsfield
6. Boston
7. N. Andover
8. Worcester
9. Lynn
10. Foxboro
11. Norwood
12. Marlboro
13. Taunton
14. Lexington
15. Chicopee
16. Ashland
17. E. Longmeadow
18. Wilmington
19. N. Attleboro
20. Acushnet

COMMONWEALTH OF MASSACHUSETTS MORTALITY RATES 1974-1978
CANCER OF THE STOMACH (I.C.D.A. 151) MALE


LEGEND
■ STATISTICALLY SIGNIFICANT AND HIGHEST DECILE
▨ STATISTICALLY SIGNIFICANT ONLY
▧ HIGHEST DECILE ONLY
☐ OTHER

The Commonwealth of Massachusetts
Department of Public Health
Cancer Registry

HOSPITAL NAME Berkshire Medical Center	CODE 313	DATE OF DIAGNOSIS M M D D Y Y 0 2 0 3 8 2	HOSPITAL RECORD NUMBER

LAST NAME	FIRST NAME	M.I. L.	SEX F	RACE 1

MAIDEN NAME (IF APPLIC.)	STREET ADDRESS	CITY/TOWN NAME Pittsfield	STATE MA

ZIP CODE 01201 -	BIRTHDATE M M D D Y Y	AGE 36	BIRTH STATE MA	SMOK. ST. 2	PRIMARY SITE 9 1 7 4 9	HISTOLOGY P 8 5 0 3	STAGE T 1 N 0 M 0

SEQ. NO. 1	CONF. 1	PLACE DX. 1	VIT. ST. 1	RESEARCH	USUAL OCCUPATION: Wirer @ General Electric Ordnance	DO NOT FILL IN. DPH USE ONLY.

NOTE: Ch. 111, s. 111B of the Massachusetts General Laws requires hospitals to report the above information. The following codes are to be used for certain of the responses. Refer to detailed instructions for further explanation.

SEX

M = Male
F = Female
U = Unknown

STATE

Use two-letter postal abbreviation. If from outside U.S., see instructions.

ZIP CODE

Use nine-digit postal Zip Code, if available. If not, code five digits to left of dash.

RACE/ETHNIC GROUP

0 = Caucasian of Spanish origin or surname
1 = Caucasian, not otherwise specified
2 = Black, including Haitian and Cape Verdean
3 = American Indian or Alaskan native
4 = Chinese
5 = Japanese
6 = Other Asian or Pacific Islander
7 = Other non-white
9 = Unknown race or ethnic group

PRIMARY SITE

Use the first block to code the classification system used (9 = ICD-9, 0 = ICD-O, etc.). See instructions for details.

AGE

Give two-digit age at last birthday. Code 01, 02, etc., if under 10 years. If 98 or older, code 98; if unknown, code 99.

HISTOLOGY

Use the first block to code the histologic system used (P = SNOP, M = SNOMED, etc.). See instructions for details.

SMOK. ST.
(Smoking Status)

0 = Never smoked cigarettes
1 = Former cigarette smoker
2 = Cigarette smoker at time of diagnosis
9 = Smoking status unknown

STAGE

Use the first block to code the staging system used on this patient (J = Am. Joint Commission, T = TNM, S = SEER, etc.). See instructions for details.

SEQ. NO.
(Sequence of Diagnosis)

1 = First primary tumor
2 = Second . . . up to
8 = Eighth or more
9 = Unspecified

CONF.
(Confirmation Method)

1 = Positive Histology
2 = Positive exfoliative histology in the absence of positive histology
3 = Positive microscopic confirmation, not otherwise specified
4 = Diagnosis made at autopsy
5 = Direct clinical visualization without microscopic confirmation
6 = Radiography without microscopic confirmation
7 = Clinical diagnosis other than #5 or #6
9 = Unknown or unspecified whether microscopic confirmation was obtained

PLACE DX.
(Place of Diagnosis)

1 = Diagnosis made at your facility (see #6, also)
2 = Diagnosis made at another Massachusetts hospital
3 = Diagnosis made in Massachusetts but not in a hospital (includes private offices)
4 = Diagnosis made in a hospital outside of Massachusetts
5 = Diagnosis made outside of Massachusetts but not in a hospital
6 = Diagnosis made at autopsy (if both #1 and #6 are true, code #6)

VIT. ST.
(Vital Status)

1 = Patient living
2 = Patient deceased

RESEARCH

Use two right-hand columns only. If you do not wish to use this option, leave blank.

Please use other side for additional clinical and diagnostic notes, as appropriate.

address have been removed. What we ask for is the "Usual Occupation" and, in this case, the person was a wirer at General Electric Ordnance - they gave us the name of the company. Then we look up the company in a manual called the "Directory of Massachusetts Manufacturers," put out by the Associated Industries of Massachusetts, where we get the Standard Industrial Classification code. Then the occupational coder (sitting here in the third row) puts that in the next space, along with the code for the occupation, and the whole record is entered into the computer and becomes the occupational cancer incidence database. We will eventually do analytic work on this ourselves in the Division of Health Statistics and Research, and we will make it available for additional epidemiologic studies that may be undertaken, after an approval process and guarantees of confidentiality, by outside research groups.

So, I just wanted to provide you that little summary to say "this is what we're doing;" this is in some ways a status report on the occupational cancer information that we're collecting at the State Cancer Registry. I'd like to conclude my part of the program with that and open up the discussion for questions.

DR. FRECHETTE: Why don't you field the discussion.

MR. CLAPP: You may want to take a deep breath - that was a lot of information. Here is the first question from Dr. Buechner.

DR. BUECHNER: I want to address a question to Rob and today's group concerning future efforts in the area of surveillance. Do you think it's better to put resources into these rather large statistical studies that are involving vital statistics or tumor registries, or go directly to longitudinal studies, maybe retrospective and getting full occupational histories, of selected occupations? Would you comment on which of these efforts you'd think would be more appropriate?

DR. DUBROW: Well, I don't think that they should be counterposed, necessarily. I think each could serve a different role. So, basically, I think they should be going on in tandem, and the roles they play are that the surveillance studies provide leads to feed into doing the more in-depth type of studies that you were describing. That would be my position on it.

DR. COLTON: I have two questions: First, a statistical question... did you look only at excesses or did you look at deficits as well? Did you look equally intensely at observed/expected ratios that would have been less than you would anticipate, perhaps suggesting that occupations are protecting against certain cancers? The second question is, in particular, about the controversy and emotional feeling about low-level radiation and cancer. Did you segregate out radiation workers as a group and look at occupation in relation to radiation producing excess cancers?

DR. DUBROW: The information is available in the study as far as occupations that had deficits of cancer, but we really didn't do a lot of analysis of that. In answer to your question about radiation, in terms of occupational groups that you can define as exposed to radiation, I don't think there really are that many in Massachusetts - there weren't really any nuclear power industry workers in our study. I guess there are a couple of nuclear power plants, but in terms of that industry being far enough along that you'd start getting a number of workers that died from it, that just wasn't available in this database. Then you have X-ray technicians and there weren't very many of those; as I mentioned previously, there perhaps would have been more if we had looked at women workers, also. So, basically, we didn't do much with radiation.

DR. COLTON: You're not saying, then, that there's no risk with radiation; you're saying you did not segregate that out and analyze it as a category?

DR. DUBROW: We couldn't segregate it out, yes.

MR. CLAPP: I'd just like to add something to that, Dr. Colton, which you probably already know. There are national studies of radiation workers ongoing, and I'm sure that some Massachusetts workers are included in those. Of the two nuclear power plants in Massachusetts, one of them, called Yankee Rowe in Western Mass., I believe, is the smallest operating nuclear power plant, and there'd be the fewest number of employees to study there. And in terms of X-ray technicians, when I looked into this, I believe there were something on the order of 5,000 in the State. But there is a national study of X-ray technicians going on, conducted by the University of Minnesota School of Public Health, which looks at a much larger worker population.

DR. GUTE: Just an additional comment, you're probably aware of this as well, but Sam Milham in Washington State did look at the nuclear power industry in a broad-based mortality analysis and did come up with some correlations between that type of employment and various types of cancer.

DR. RATNEY: All three of the panelists are talking about the problems with the Cancer Registry data or death certificates in terms of "Usual Occupation." First of all, in your registries, how do you define "usual employment?" Is there any way of getting occupational histories; Americans are notorious for changing jobs... I don't mean jobs, but changing firms, so that you really want to know what the guy's been doing all his life.

MR. CLAPP: The question was about the term "usual employment" or "usual occupation," which is on both the death certificate and the Cancer Registry form. What does that mean? And, also, is there any way of getting an occupational history in either the death certificate studies or the cancer registry studies? First, the death certificate studies.

DR. DUBROW: Well, the "Usual Occupation" means what you think it would mean... the occupation that a person did perform during most of their life, and there, obviously, are a lot of problems with that on a death certificate. First, you're not getting the information directly from the person; you're getting it from the next of kin or even someone who didn't know the person as well as the next of kin would have. Really, the only way of trying to improve that information would be through educational programs, through setting certain guidelines and then having programs to educate funeral directors who collect that information.

On the other hand, there is the potential for getting a lot more than that from a cancer registry approach, which is one of the reasons why it's so much more preferable. At least in principle, you could get a whole occupational history, if you're allowed to interview the patients.

MR. CLAPP: Rose, did you want to add something?

DR. GOLDMAN: I'd just like to add a comment about a program which speaks to this which is going on in Montreal. They've organized a system, just quickly to summarize it, which involves all of the major hospitals where every cancer patient is interviewed and a complete occupational history is taken. Then, an independent industrial hygienist or chemical engineer assigns a probable exposure to each case. This gives not only an occupational history, but also estimates an exposure history for each cancer case.

MR. CLAPP: That represents the ideal situation, but in practice, that would take an enormous amount of additional money and staff, and, frankly, we don't ever expect to have the resources to do that in the Massachusetts Cancer Registry.

Ms. Kellogg, did you want to make an announcement?

MS. KELLOGG: This is an announcement that the Massachusetts "Right-to-Know" bill is set for public hearings on March 9. We have summaries of the bill and other information in the back of the room if you want to pick it up when you leave.